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(54) Title: REDUCTION OF ACRYLAMIDE FORMATION

(57) Abstract: The invention relates to the use of acid treatment of uncooked French fries prior to cooking by roasting, frying, grilling or baking whereby to reduce the acrylamide content of the cooked product.

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Reduction of acrylamide formation

5 The present invention relates to improvements in  
and relating to French fries.

In a publication by the Swedish National Food  
Administration (see [www.slv.se/engdefault.asp](http://www.slv.se/engdefault.asp)) it was  
reported that many cooked foods, in particular fried,  
grilled or baked foods, had surprisingly been found to  
10 contain high levels of the toxic contaminant acrylamide.  
No suggestion was made as to how the acrylamide context  
of such foods could be reduced.

A further report of acrylamide production in food  
cooking occurred in Tareke et al., J. Agric. Food Chem  
15 50: 4998-5006 (2002).

We have now surprisingly found that the acrylamide  
content of French fries can be reduced by treatment of  
the French fries prior to cooking with lactic acid  
generating microorganisms and/or with acid.

20 Thus viewed from one aspect the invention provides  
the use of a lactic acid producing microorganism for the  
treatment of uncooked French fries or flour for use in  
the preparation of uncooked French fries to reduce  
acrylamide production in subsequent cooking thereof.

25 Lactic acid producing microorganisms are well known  
and examples include lactic acid bacteria such as  
Bifidobacterium sp., Brevibacterium sp., Lactobacillus  
sp., Lactococcus sp., Leuconostoc sp., Micrococcus sp.,  
Oenococcus sp., Pediococcus sp., and Streptococcus sp.  
30 Lactobacilli are especially preferred for use according  
to the invention, in particular Lactobacillus plantarum  
strains NCDO 1752 and NCDO 1193 (available from the  
National Collection of Food Bacteria) and Lactobacillus  
NCIMB 40450. Other strains of lactobacillus which  
35 generate lactic acid and are safe for use in foodstuff  
treatment have been described widely in the scientific  
literature.

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The treatment with a lactic acid producing microorganism according to the invention preferably involves incubation in an aqueous medium for up to 7 days, e.g. 30 minutes to 24 hours, especially 1 to 6 hours. Incubation is preferably at 4 to 45°C, e.g. 25 to 35°C, i.e. as is conventional for such microorganisms.

Typically such treatment may involve homofermentative lactic acid bacteria incubation in an aqueous medium.

Viewed from a further aspect the invention provides the use of a physiologically acceptable acid for the treatment of uncooked French fries or flour for use in the preparation of uncooked French fries to reduce acrylamide production in subsequent cooking thereof.

The physiologically tolerable acid used according to the invention may be any acid acceptable for use in foodstuffs, e.g. organic acids, such as citric, malic, acetic, maleic, tartaric, succinic and lactic acids or inorganic acids such as hydrochloric, sulphuric and phosphoric acids and sulphur dioxide. The use of citric and hydrochloric acids is especially preferred, as is the use of lactic acid and/or of phosphoric acid. The use of hydrochloric acid is especially preferred. The acid is preferably used in a quantity and strength sufficient to reduce the surface pH of the uncooked French fries treated to 1 to 5.5, preferably 3 to 5, especially about 4. Following acid treatment, the uncooked French fries are preferably stored for up to 7 days (e.g. 30 minutes to 24 hours, especially 1 to 6 hours before cooking or freezing).

In this process, the acid is preferably used in the form of a buffer solution.

Following treatment with the acid and/or the lactic acid producing microorganism, the uncooked French fries may be cooked using cooking techniques that expose the product to temperatures above 150°C, e.g. by baking,

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grilling, roasting or frying.

Before such high temperature cooking, it is desirable to rinse the treated uncooked product with water.

5           The cooking may be a single stage operation. However it may instead be one stage of a multi stage (e.g. two stage) cooking procedure. Thus the technique of the invention is especially applicable to French fries which are treated according to the invention, partially cooked, transported and/or stored, then cooked  
10 again.

Where appropriate, the products produced according to the invention may be further processed, e.g. by drying, freezing, sealing into moisture proof containers  
15 etc. Such processing steps, which are often conventional for French fries, form further optional steps in the processes of the invention.

The invention is especially applicable for the production of so-called oven-ready french-fried potatoes  
20 which are provided to the consumer in part-cooked form for baking prior to serving, as well as to the production of chopped ready-to-fry potatoes (e.g. of the type produced for deep frying in restaurants).

Thus viewed from a further aspect the invention  
25 provides a process for the preparation of ready to cook (e.g. oven-ready or ready to fry) french fried potatoes which process comprises chopping potatoes, fermenting the chopped potatoes with a lactic acid producing microorganism, frying the fermented chopped potatoes,  
30 and optionally loading the fried fermented chopped potatoes in a container, and optionally sealing the container.

Viewed from a still further aspect the invention provides a process for the preparation of ready to cook  
35 (e.g. oven-ready or ready to fry) french fried potatoes which process comprises chopping potatoes, treating the chopped potatoes with a physiologically acceptable acid,

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frying the acid treated potatoes, and optionally loading the fried potatoes into a container, and optionally sealing the container.

5 The chopping stage in this process is preferably such as to produce batons having a cross-sectional area of 10 to 100mm<sup>2</sup>, especially preferably 25 to 80mm<sup>2</sup>.

10 The container used in these processes will typically be a plastic bag, paper carton or bag or other container conventionally used for storage and transport of ready to cook french fries.

Viewed from a still further aspect the invention thus also provides a container containing ready to cook (e.g. oven-ready or ready to fry) french fried potatoes produced by frying chopped potatoes pre treated with a  
15 lactic acid producing microorganism and/or with a physiologically acceptable acid.

French-fries are preferably made from sliced potato; however they may also be made from extruded or moulded carbohydrate-containing pastes produced using  
20 powdered or granulated potato and/or cereal (e.g. rice).

Thus in alternative aspects of the invention the uncooked French fries may be produced from potato and/or cereal flour fermented with a lactic acid producing microorganism or treated with an acid as described  
25 herein before being moulded or extruded in paste form into French-fry shapes and then cooked. If desired, the fermentation or acid treatment may be effected on French fry shapes moulded or extruded using a potato and/or cereal flour based paste.

30 The potatoes treated according to the invention are preferably of a variety selected from Maris Piper, Beate or Russet, especially Maris Piper. Saturna, King Edward, Russet Burbank, Bintje, Shepady and Shasta may also be used. Especially preferably the potatoes are  
35 selected from varieties having a reducing sugar content of less than 1.5% wt, particularly less than 1.0% wt.

Besides the fermentation and/or acid treatment

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according to the invention, the French fries of the invention may be prepared by conventional methods, optionally involving rinsing and/or drying after the treatment. Thus such French fries may optionally  
5 contain further components, such as conventional foodstuff components or additives, e.g. salt, sugars, flavours, stabilizers, buffers, etc.

The invention will now be illustrated further with reference to the following non-limiting Example.

10

Example 1

French fries

**Ingredients**

15 Potatoes of the variety Beate were obtained from Department of Horticulture and Crop Sciences, Agricultural University of Norway, Ås. The potatoes were stored at 8°C from harvest until three weeks prior to processing when storage temperature was reduced to  
20 4°C.

Palm oil was obtained from Denofa AS, Frederikstad, Norway. The oil had maximum 0.05% free fatty acids, an iodine number of 60, a peroxide value of 0.5 mekv/kg and  
25 an anisidin number of 5.0. Fatty acid composition was: 12% linoleic acid, 42% oleic acid and 45% saturated fatty acids.

The *Lactobacillus* strain NCIMB 40450 was used. Bacteria  
30 cells were grown and harvested in the logarithmic growth phase by centrifugation and resuspended in 1% salt brine.

The soaking solution used was:  
35 Brine for fermentation: 1% NaCl with the addition of bacteria until  $1 \times 10^6$  cells/ml

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**Pre-treatment of potatoes**

Potatoes (var. Beate) were peeled and cut with a knife into 6 x 6-mm sticks. The sticks (200g) were immediately added to 400 mL of brine. Fermentation was allowed to proceed in an incubator at 30°C for 5 hrs. Control samples were rinsed in water and deep-fried without delay.

**Deep frying**

The potatoes were dried with paper towels and deep-fried as 150-g portions in palm oil at 170°C in a Nuovo Elframo, Model EB (Bergamo, Italy) fryer for 8 min.

**Analyses**

Dry matter was determined in a vacuum oven at 70°C overnight. pH of brines was determined using a pH-meter. Soluble solids of potatoes were determined as °Brix using a Metler Toledo RE40 refractometer. Samples were homogenised and a few drops of the homogenates were applied on the refractometer. °Brix is given as g sucrose/100g sample.

Accredited analyses of acrylamide were carried out at Steins Laboratorium, Denmark.

**Results**

The °Brix-value of the potatoes (var. Beate) was 6.8.

Results from the analyses of deep-fried products are shown in Table 1 below.

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Table 1

| Pre-treatment | pH in brine<br>after pre-<br>treatment | Dry matter                 |                        | Acrylamide       |                          |
|---------------|--|----------------------------|------------------------|------------------|--------------------------|
|               |  | g/100g<br>fried<br>product | µg/kg<br>dry<br>matter | µg/kg<br>product | % reduction<br>(product) |
| -control      | 6.7*                                   | 86.0                       | 744                    | 640              | 0                        |
| -fermented    | 4.3                                    | 85.3                       | 469                    | 400              | 38                       |

\* tap water

- 10 The samples within each of the product groups were deep-fried for the same period of time, rather than being deep-fried until a certain product colour. Any difference in acrylamide levels thus reflects the ability of the treatment to prevent the formation of
- 15 acrylamide, regardless of the colour that might be formed during deepfat-frying.



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Claims:

1. The use of a lactic acid producing microorganism for the treatment of uncooked French fries or flour for use in the preparation of uncooked French fries to reduce acrylamide production in subsequent cooking thereof.
2. Use as claimed in claim 1 of a lactic acid bacterium.
3. The use of a physiologically acceptable acid for the treatment of uncooked French fries or flour for use in the preparation of uncooked French fries to reduce acrylamide production in subsequent cooking thereof.
4. Use as claimed in claim 3 of an acid selected from lactic, citric, phosphoric and hydrochloric acids.
5. A process for the preparation of ready to cook french fried potatoes which process comprises chopping potatoes, fermenting the chopped potatoes with a lactic acid producing microorganism, frying the fermented chopped potatoes, and optionally loading the fried fermented chopped potatoes into a container.
6. A process for the preparation of ready to cook french fried potatoes which process comprises chopping potatoes, treating the chopped potatoes with a physiologically acceptable acid, frying the acid treated potatoes, and optionally loading the fried potatoes into a container.
7. A container, preferably a sealed container, containing oven-ready french fried potatoes produced by frying chopped potatoes pre treated with a lactic acid producing microorganism and/or a physiologically

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acceptable acid.

8. French fries produced by a process as claimed in  
claim 5 or claim 6 or by way of a use as claimed in any  
5 one of claims 1 to 4.

# INTERNATIONAL SEARCH REPORT

PCT/GB 03/04066

## A. CLASSIFICATION OF SUBJECT MATTER

IPC 7 A23L1/105 A23L1/03 A21D8/04 A23L1/217 B65D77/30  
B65D81/34

According to International Patent Classification (IPC) or to both national classification and IPC

## B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

IPC 7 A23L A21D B65D

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practical, search terms used)

EPO-Internal, PAJ, WPI Data, FSTA, BIOSIS

## C. DOCUMENTS CONSIDERED TO BE RELEVANT

| Category * | Citation of document, with indication, where appropriate, of the relevant passages   | Relevant to claim No. |
|------------|--|-----------------------|
| Y          | DATABASE WPI<br>Section Ch, Week 199815<br>Derwent Publications Ltd., London, GB;<br>Class D11, AN 1998-162469<br>XP002268083<br>& JP 10 028516 A (KAO CORP)<br>3 February 1998 (1998-02-03)<br>abstract     | 1,2,5,8               |
| Y          | DATABASE WPI<br>Section Ch, Week 199712<br>Derwent Publications Ltd., London, GB;<br>Class D13, AN 1997-126328<br>XP002268084<br>& JP 09 009862 A (AJINOMOTO KK)<br>14 January 1997 (1997-01-14)<br>abstract | 1,2,5,8               |



Further documents are listed in the continuation of box C.



Patent family members are listed in annex.

### \* Special categories of cited documents :

"A" document defining the general state of the art which is not considered to be of particular relevance

"E" earlier document but published on or after the international filing date

"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)

"O" document referring to an oral disclosure, use, exhibition or other means

"P" document published prior to the international filing date but later than the priority date claimed

"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention

"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone

"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art.

"&" document member of the same patent family

Date of the actual completion of the international search

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# INTERNATIONAL SEARCH REPORT

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## C.(Continuation) DOCUMENTS CONSIDERED TO BE RELEVANT

| Category ° | Citation of document, with indication, where appropriate, of the relevant passages  | Relevant to claim No. |
|------------|---|-----------------------|
| Y          | WO 01/78524 A (NOVOZYMES AS ;NOVO NORDISK BIOTECH INC (US))<br>25 October 2001 (2001-10-25)   | 1,2,5,8               |
| X          | * page 2, lines 23-24; page 7, line 27 -<br>page 8, line 7; examples 1-3; claims 1-3,<br>5, 6, 16-21, 23, 25, 26 and 39 *   | 8                     |
| A          | "Brief Communications, ACRYLAMIDE IS<br>FORMED IN THE MAILLARD REACTION"<br>NATURE, MACMILLAN JOURNALS LTD. LONDON,<br>GB,<br>vol. 419, 3 October 2002 (2002-10-03),<br>pages 448-449, XP002235161<br>ISSN: 0028-0836<br>* page 448, column 2, paragraph 2 - column<br>3, paragraph 1; page 448, column 3,<br>paragraphs 5-6 *  | 1,2,5,8               |
| A          | TAREKE E ET AL: "analysis of acrylamide,<br>a carcinogen formed in heated foodstuffs"<br>JOURNAL OF AGRICULTURAL AND FOOD<br>CHEMISTRY, AMERICAN CHEMICAL SOCIETY.<br>WASHINGTON, US,<br>vol. 50, 17 July 2002 (2002-07-17), pages<br>4998-5006, XP002237517<br>ISSN: 0021-8561<br>cited in the application<br>* page 5002, column 1, last paragraph -<br>page 5004, column 2, last paragraph * | 1,2,5,8               |
| A          | DATABASE WPI<br>Section Ch, Week 197740<br>Derwent Publications Ltd., London, GB;<br>Class A14, AN 1977-71839Y<br>XP002268085<br>& JP 52 102489 A (TAKI CHEMICAL KK)<br>27 August 1977 (1977-08-27)<br>abstract   | 1,2,5,8               |
| A          | DATABASE WPI<br>Section Ch, Week 197835<br>Derwent Publications Ltd., London, GB;<br>Class A35, AN 1978-62780A<br>XP002268093<br>& JP 53 086079 A (TAKI KAGAKU KK)<br>29 July 1978 (1978-07-29)<br>abstract   | 1,2,5,8               |

# INTERNATIONAL SEARCH REPORT

PCT/GB 03/04066

## Box I Observations where certain claims were found unsearchable (Continuation of item 1 of first sheet)

This International Search Report has not been established in respect of certain claims under Article 17(2)(a) for the following reasons:

1. ☐ Claims Nos.:  
because they relate to subject matter not required to be searched by this Authority, namely:
  
2. ☐ Claims Nos.:  
because they relate to parts of the International Application that do not comply with the prescribed requirements to such an extent that no meaningful International Search can be carried out, specifically:
  
3. ☐ Claims Nos.:  
because they are dependent claims and are not drafted in accordance with the second and third sentences of Rule 6.4(a).

## Box II Observations where unity of invention is lacking (Continuation of item 2 of first sheet)

This International Searching Authority found multiple inventions in this international application, as follows:

see additional sheet

1. ☐ As all required additional search fees were timely paid by the applicant, this International Search Report covers all searchable claims.
  
2. ☐ As all searchable claims could be searched without effort justifying an additional fee, this Authority did not invite payment of any additional fee.
  
3. ☐ As only some of the required additional search fees were timely paid by the applicant, this International Search Report covers only those claims for which fees were paid, specifically claims Nos.:
  
4. ☒ No required additional search fees were timely paid by the applicant. Consequently, this International Search Report is restricted to the invention first mentioned in the claims; it is covered by claims Nos.:

1,2,5,8 (partially)

### Remark on Protest

- ☐ The additional search fees were accompanied by the applicant's protest.
- ☐ No protest accompanied the payment of additional search fees.

FURTHER INFORMATION CONTINUED FROM PCT/ISA/ 210

This International Searching Authority found multiple (groups of) inventions in this international application, as follows:

1. claims: 1, 2, 5, 8 (partially)

Use of a lactic acid producing microorganism for the treatment of a uncooked French fries or flour for use in the preparation of uncooked French fries to reduce acrylamide production in subsequent cooking thereof.

Process for the preparation of ready to cook french fried potatoes which process comprises chopping potatoes, fermenting the chopped potatoes with a lactic acid producing microorganism, frying the fermented chopped potatoes, and optionally loading said fried fermented chopped potatoes into a container.

French fries produced by said process or being the result of the aforementioned use.

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2. claims: 3, 4, 6, 8 (partially)

Use of a physiologically acceptable acid for the treatment of uncooked French fries or flour for use in the preparation of uncooked French fries to reduce acrylamide production in subsequent cooking thereof.

Process for the preparation of ready to cook french fried potatoes which process comprises chopping potatoes, treating the chopped potatoes with a physiologically acceptable acid, frying the acid treated chopped potatoes, and optionally loading said fried potatoes into a container.

Food products produced by said process or by way of the aforementioned use.

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3. claim: 7

Container containing oven-ready french fried potatoes produced by frying chopped potatoes pre-treated with a lactic acid producing microorganism and / or a physiologically acceptable acid.

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# INTERNATIONAL SEARCH REPORT

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## Information on patent family members

| Patent document<br>cited in search report |   | Publication<br>date | Patent family<br>member(s)   | Publication<br>date                                  |
|---|---|---------------------|--|--|
| JP 10028516                               | A | 03-02-1998          | NONE   |  |
| JP 9009862                                | A | 14-01-1997          | NONE   |  |
| WO 0178524                                | A | 25-10-2001          | AU 5539201 A<br>EP 1276389 A2<br>WO 0178524 A2<br>US 2002004085 A1 | 30-10-2001<br>22-01-2003<br>25-10-2001<br>10-01-2002 |
| JP 52102489                               | A | 27-08-1977          | JP 1092993 C<br>JP 55050477 B                                      | 16-04-1982<br>18-12-1980                             |
| JP 53086079                               | A | 29-07-1978          | JP 1099041 C<br>JP 56044799 B                                      | 18-06-1982<br>21-10-1981                             |